BALLOON LAUNCHING FACILITIES IN ARGENTINA

GENERAL INFORMATION

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COMISION NACIONAL DE INVESTIGACIONES ESPACIALES

BALLOON DIVISION

I. INTRODUCTION

There are well known reasons to conduct balloon-born scientific experiments all over the world. Physics of the middle and upper atmosphere, solar physics, UV, X-ray and γ-ray astronomy, cosmic rays and, more recently, infrared astronomy and magnetospheric physics utilize the stratospheric balloon as a platform to carry out experiments close to the top of the atmosphere.

Most balloon launchings were and are still carried out from the Northern Hemisphere and, to a lesser extent, from the Southern Hemisphere. But obviously there remain many scientific problems for which flights in the Southern Hemisphere are mandatory.

Argentine continental territory extends from 22°S down to 55°S and this offers a wide range in latitude for balloon launchings. However, its Northern half portion is the widest and, in turn-around periods, flights lasting many hours over its territory can be performed.

Launching sites at approximately 30°S offer certain advantages, particularly for astronomy and cosmic ray research. For instance, the galactic center culminates nearly overhead; and within the Argentine longitude range, the relatively high geomagnetic cut-off rigidity for primary cosmic rays -above 10 GV- in the Northern part of the country assures a comparatively low atmospheric background for cosmic rays and X- and γ-ray astronomy.

Since its beginnings in the early 60's, CNIE supported balloon activities in Argentina, and more recently created its own Balloon Division which is in charge of organizing and implementing balloon launchings in the country.

Launching facilities in Argentina have been improving in the last few years. This brochure describes those presently available, particular-

ly at the Mendoza Balloon Launching Station, and presents some technical data which is considered necessary for potential users. The same as in the past, the possibility of launching scientific balloons from Argentina is open to national and foreign scientific groups.

2. SCIENTIFIC BALLOON LAUNCHINGS IN ARGENTINA

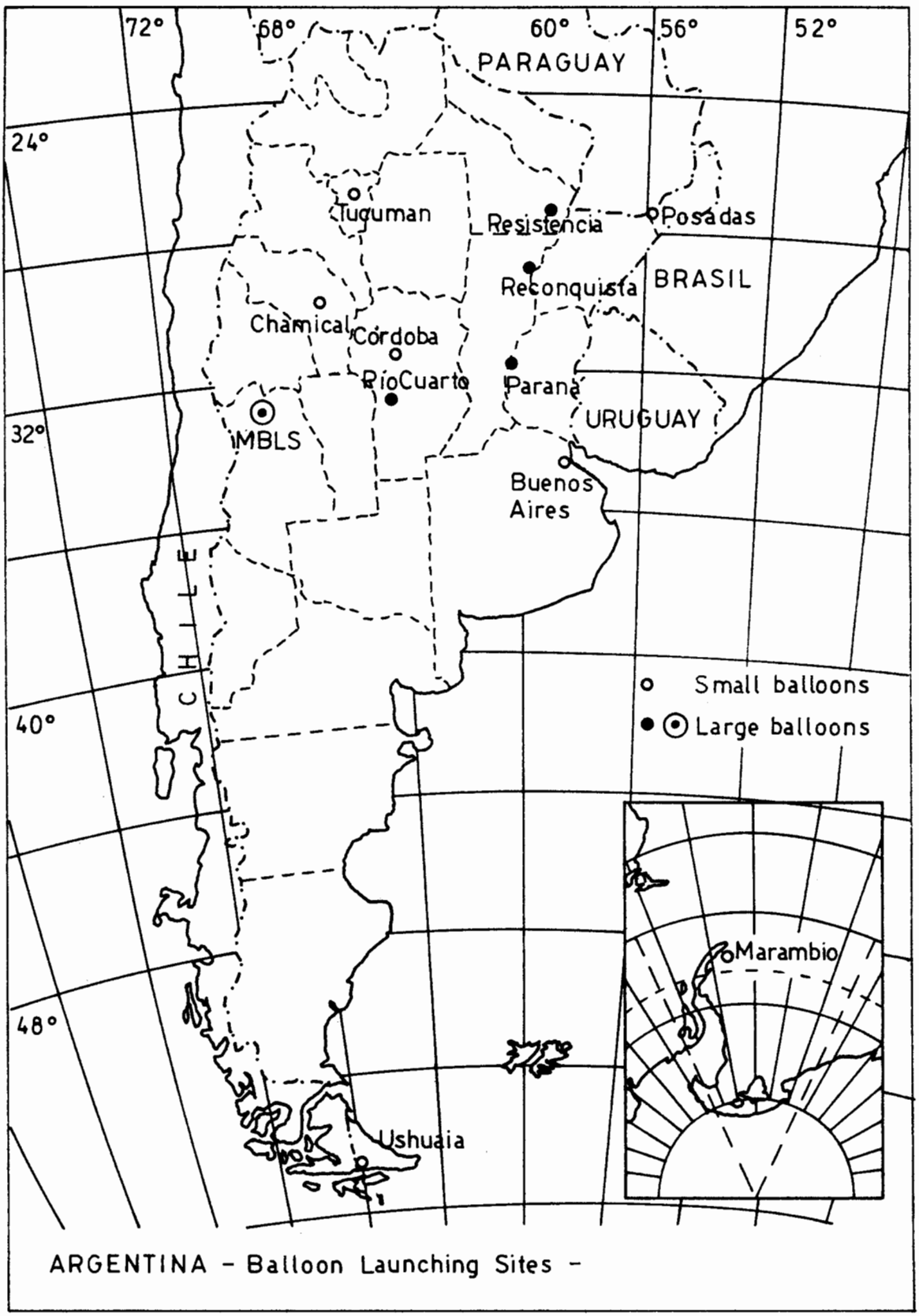
The first scientific balloon launchings in Argentina, finantially supported by CNIE, were made by local groups at the beginning of 1962.

The first foreign expedition came to this country in 1964 when W.Webber, then at the University of Minnessota, USA, launched four balloons from Tucumán, in Northern Argentina.

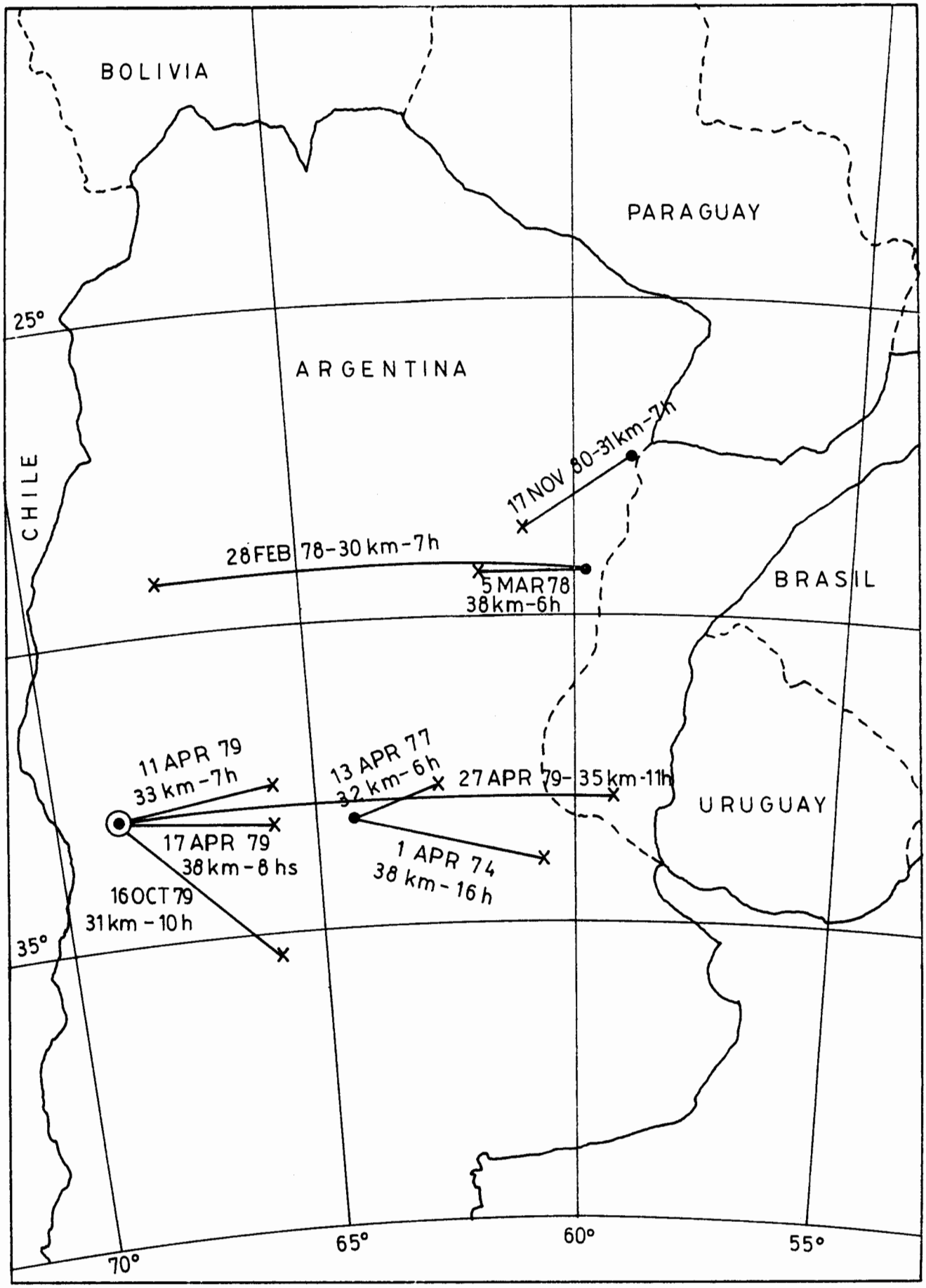
In 1971 the launching of several hundred free-superpressure-tropospheric balloons for the French satellite EOLE experiment took place from three stations located at Mendoza, Neuquén and Tierra del Fuego, with CNIE's cooperation.

Since 1969 several foreign expeditions arrived in the country. In these so called Galaxy Campaigns, sponsored and coordinated by CNIE, large stratospheric balloons, up to 20 million cubic feet, were launched from Paraná, Rio Cuarto and Reconquista Air Force Bases. Scientists from USA, U.K. and FRG universities and research institutes, jointly with Argentine scientists, participated of these campaigns, providing experiments in the fields of atmospheric, ionospheric and solar physics, hard X-rays, γ-rays and far infrared and cosmic rays.

Initially the Argentine balloon launchings were performed by local university groups jointly with CNIE's personnel. At that time, launching, flight control and recovery operations for foreign expeditions were carried out by the USA National Scientific Balloon Facility (NSBF) team with the cooperation of CNIE's personnel.



ARGENTINA - Balloon Launching Sites -



Balloon Trayectories

In 1977 CNIE decided to organize its own balloon launching team; thus some personnel were trained at the NBSF in Palestine, USA. Since then, the launching and flight operations of large plastic balloons are performed by the launching team of CNIE's Balloon Division.

The possibilities of launching large balloons increased through the years with the incorporation of equipment obtained through the NBSF and equipment purchased by CNIE.

3. LAUNCHING SITES

Several balloon launching campaigns, for national and foreign groups were carried out from different places, mostly in the Northern part of the Argentine territory. In addition to a Navy vessel in the midst of the Atlantic Ocean, from which several launchings took place in 1963, facilities and runways of Air Force or commercial airports were utilized. After and before the autumn and spring wind inversion, many small balloon flights were carried out from Buenos Aires as well as Tucumán, Posadas, Chamical, Córdoba and Ushuaia throughout the year. In 1965, some flights took place from Marambio Air Force Base in the Antarctic region. The largest balloons were launched from Rio Cuarto (33°07'S; 64°14' W) in central Argentina, and Mendoza (33°S; 69°W). In October, November and December, launchings were made from stations along the Paraná River, on the eastern side of the country: Paraná (31°41'S: 60°22'W), Reconquista (29°11'S; 59°40'W) and Resistencia (27°27'S; 60°22'W) airports.

In 1979 the launching of large plastic balloons was initiated at Mendoza base, which has been CNIE's permanent balloon launching station since then.

4. MENDOZA BALLOON LAUNCHING STATION (MBLS)

The MBLS started operations in the early 70's as one of the launching stations for the EOLE experiment. Later on CNIE decided to establish there its permanent base for large free stratospheric balloon launchings.

4.1. Location and Access

The MBLS is located in the outskirts of the city of Mendoza, capital of the province of Mendoza, on the eastern side of the Andes Mountain Range. Its geographic coordinates are:

Latitude : 32°52'S
Longitude : 68°52'W
Altitude : 827 m

The facilities are within the bounds of Aeroparque Mendoza, a small provincial airport. The use of its runway for balloon launchings and airplane operations is granted by an agreement between CNIE and the provincial government.

Mendoza city can be easily reached by land and air from Buenos Aires and other main cities in the country. Commercial and large heavy planes may land at the nearby International Airport El Plumerillo, some 10 km from the station.

Buenos Aires is 1090 km from Mendoza by road.

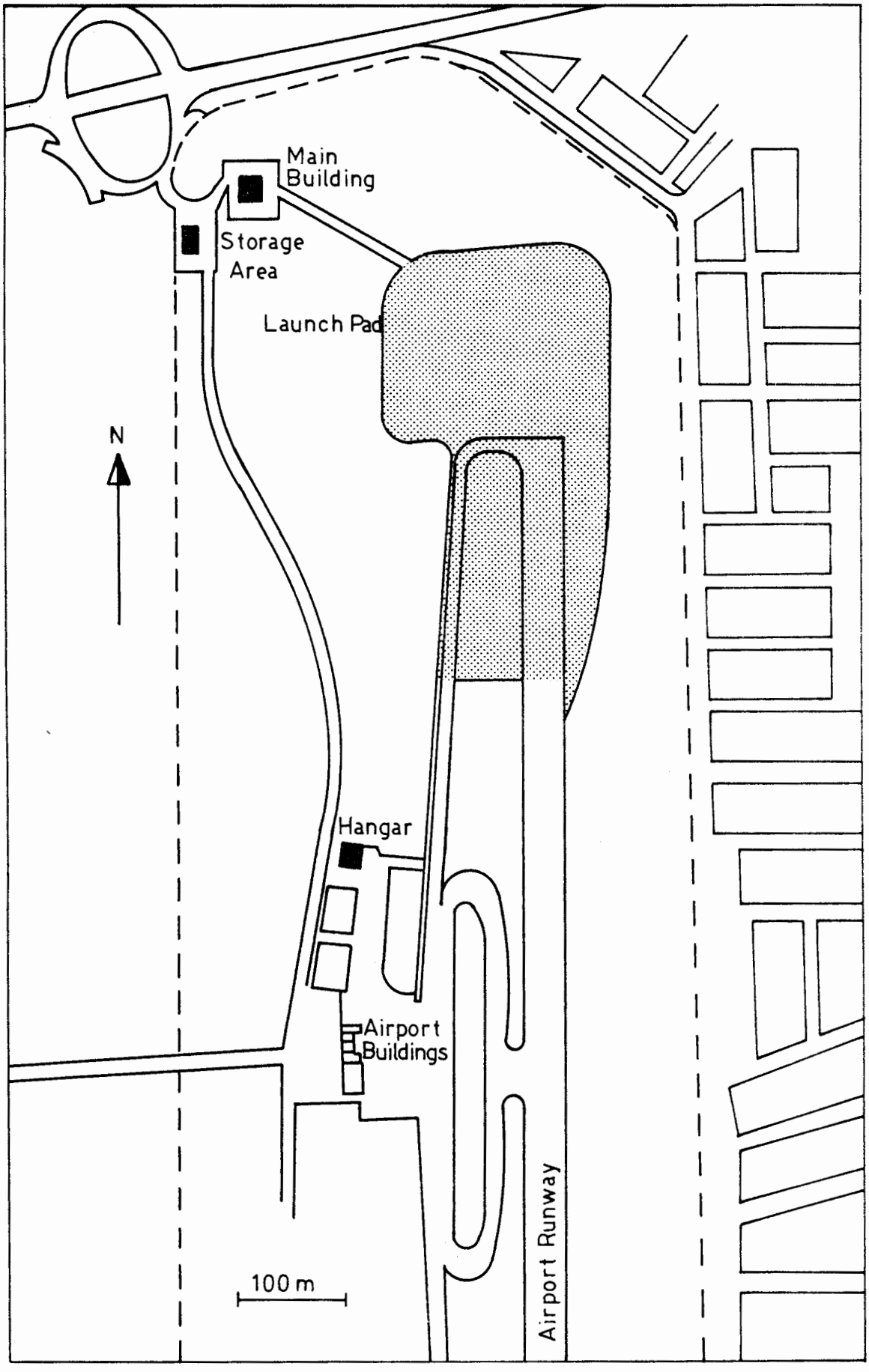
4.2. Facilities

Since 1979 the MBLS is being used regularly for national scientific balloon experiments. Presently its facilities are being improved for local and international use.

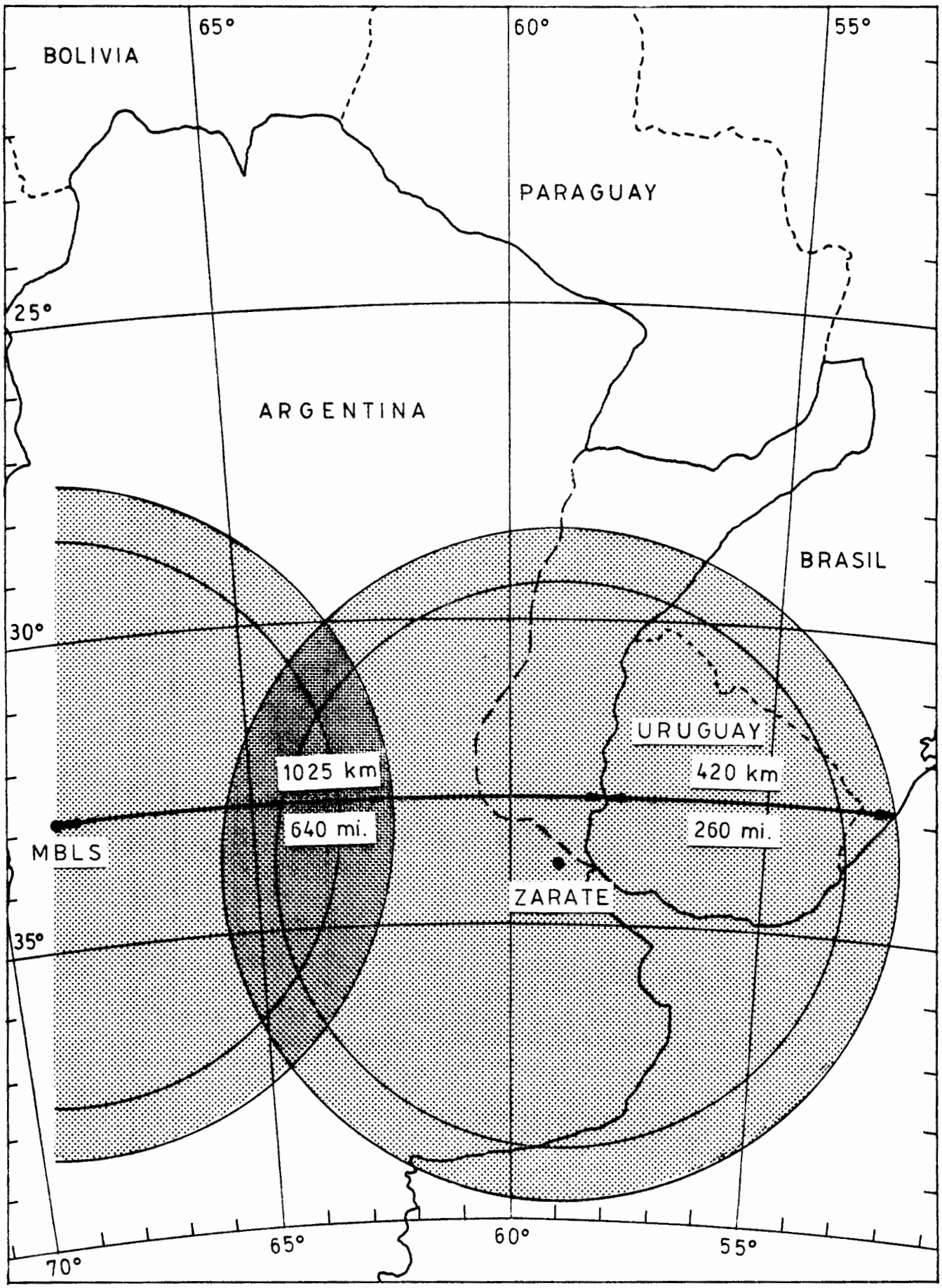
4.2.1. Launch Pad

The airport runway, about 1.8 km long, oriented N-S, has been used for balloon launchings. The terrain at its north head is now being leveled and consolidated, to add initially a 200 x 160 m^2 platform to the pad.

The launching field can be lighted for night flights. Besides standard fire-equipment at the station, a fire truck operates on the pad during launching operations.



Mendoza Balloon Launching Station - Aeroparque Mendoza -



FLIGHT RANGE FOR LAUNCHINGS FROM MBLS AND TELEMETRY COVERAGE WITH A DOWN RANGE STATION AT ZARATE, PROV. BUENOS AIRES.

4.2.2. Buildings

The station main facilities are located in a 15m height, 3-storey building set up for the French satellite EOLE experiment in the early 70's. early 70's.

In its ground floor there is room for two scientific groups, the flight operations crew, a small mechanical workshop, kitchen and sanitary services.

The first floor will lodge the flight control and experimenter telemetry rooms, a meteorological office and the radio communications station. On the upper floor a single room, about 18 x 18 m^2, can also be used for the experimenter's payloads layout and equipment no more than a few hundred kilograms in weight.

An already existing hangar, about 350 m^2, and another storage area are to be added to the facilities.

Line tension at the MBLS main building is two-phase 220 V AC, 50 Hz or three-phase 380 V AC, 50 Hz. Power available is 150 KVA.

4.2.3. Operations Team, Balloon Inflation and Launching equipment.

A ten member team is available for balloon launchings and flight operations, during launchings campaigns. Of those ten, five people stay at the station permanently for equipment maintenance.

Balloons are launched with the dynamic method. A launching vehicle able to handle payloads up to 1200 kg is available. Heavy cranes handling payloads up to several tons can be rented at Mendoza City; these cranes can be used as launching vehicles.

Apple-core type spools (apt to handle up to 40 MCF), inflation hoses, balloon handling vehicles, etc. are available.

Three hydrogen containers owned by the station with a lifting force of 800 kg each are available. Additional hydrogen tanks of 1700 m^3 (NPT), can be rented at the hydrogen supplier if necessary.

The static launching method using an auxiliary balloon to hold the payload can be used for relatively light payloads, if necessary.

4.2.4. Telemetry, Command and Flight Control Facilities

There are both ground and flight systems for command and telemetry necessary to control the flight. The experimenter may use some command and telemetry channels (for details see Apendix).

4.2.5. Balloon Tracking and Payload Recovery

The angular position of the balloon -azimuth and elevation- and the slant range can be tracked from the ground station with an accuracy of $\pm$ 2°and $\pm$ 4 km, respectively (See Appendix).

For tracking and recovery a twin motor pressurised ADF equipped aircraft is also available for the campaign. If necessary, an ADF equipped helicopter can be used for payload recovery. Recovery ground vehicles and personnel are provided by the station.

4.3. Climate and Weather Conditions

The climate at Mendoza is quite pleasant throughout the year. For details on climatological data see Figure . The launching epoch is cold but sunny and very pleasant to work.

4.3.1. Stratospheric Winds

Stratospheric winds define the epoch for the balloon experiments to be performed from Mendoza. High altitude zonal winds blow on the average from the West between mid March to the end of October, but due to the well known high dispersion of high altitude wind direction at mid-winter, the launching windows are roughly from mid March to the end of June, September and October.

4.3.2. Surface Winds

Surface wind conditions for launching operations are generally good during the launching epoch, except in early afternoon hours.

Long range meteorological data on surface winds were provided by the National Meteorological Service Climatological Station at Parque San Martin, 2 km South from the MBLS, and were corroborated during the launching campaigns. A shorter statistics is available from the MBLS meteorological office.

Except for early afternoon hours the average number of calms is about 20 days per month, and the strongest average surface winds can be meteorologically classified as gentle breezes, with wind speed below 10 knots.

Considering the combined wind conditions at surface and stratospheric levels, the months of March, April, September and October are the most appropiate for the launching campaigns from the MBLS. On the other hand, the best conditions on surface wind are given during May and June, but stratospheric westerlies are the strongest, though well defined. During July and August surface winds are also good, but stratospheric wind direction below 40 km is uncertain.

Predominant surface wind direction at launching hours is from the southern sector, mostly along the axis of the runway of the airport.

4.3.3. Meteorological Support

A synoptic meteorlogical station operates at the International Airport El Plumerillo, where local data and information from the National Meteorological Network, which covers the whole country, is provided to the MBLS.

During balloon launching campaigns a weather forecaster will assist flight operations at MBLS.

APPENDIX

Mendoza Balloon Launching Station

A. Telemetry, Command and Flight Control and Balloon Tracking Facilities

Telemetry, command and flight control systems in use at presente are based on equipment purchased from RAVEN Industries Inc.. The specifi cations of the different systems are as follows:

A.1. On Board Equipment

A.1.1. Telemetry

Modulation: FM - FM, IRIG STANDARDS (± 7.5%)
Number of subcarriers: 16; seven of them are commutable
Calibration marks: 0; +5 VDC
Input level: 0; +5 VDC
Modulation bandwidth: 250 MHz
Transmitter frequencies: 1525. 5;1527. 5;1529.5;1531.5 and 1533.5 MHz
Transmitter power; 2.0 Watts

A.1.2. Command

Receiver frequency: 149.4 MHz
Reception Mode: Narrow band FM
Receiver sensitivity: 5μV from a 50 Ω source
Private line frecuencies: 103.2 Hz and 118.8 Hz
Number of Channels: 36 maximum
Decoding mode: by resonant reed relays
Command reception verification through telemetry

A.1.3. Altitude Sensors

From ground level to 30 km, CIC - model 7000
From 30 km to 50 km, Rosemount model 830 J3
Automatic baroswitch commutation at 30 km

A.1.4. Other Features

Facilities for automatic retransmission

Beacon at 1680 Hz

A.1.5. Power Supply

Rechargable batteries, 24 VDC - 40 Ah

Total load current requirement 1.25 A.

A.1.6. Mechanical Specifications

Aluminum cilindrical box, 50 cm height x 35 cm diameter. Water proof and thermally isolated with 5 cm poliuretane foam.

Weight including battery pack: 40 kg

A.1.7. Environmental Specifications

Temperature range: inside - 30°C to +70°C, outside - 60°C to +100°C

Humidity: 100%

Altitude: not limited

Impact: 5g along any axis

A.2. Ground Station

A.2.1. Telemetry Reception

Antenna: parabolic type, 1.8 m diameter

Feeder : simple dipole on parabole focus and 4 simple dipoles for automatic tracking

Gain : 16 db over dipole

Pointing: servo motor controlled automatic tracking and manual operation modes

Tracking speed: 3° per second maximum

Tracking sensitivity: $\pm$ 1°

Operation range: -5°.to 365° Azimuth;

-2° to 93° Elevation

Power requirements: 110 VAC-350 W

Environmental conditions: maximum wind speed during operation 30 knots.

Receiver

DEI Receiver with dial or crystal controlled frequency

Sensitivity: 5 μV from 50 Ω source

Bandwith: selectable from 10kHz to 1MHz

Video bandwith: " " 3kHz to 1MHz

Reception mode: AM/FM; AC-DC

Automatic frequency tracking

Tuning, peak deviation and input signal indicators

Reception range including antenna system

Automatic mode: 270 km

Manual mode: 540 km

A.2.2. Discriminators

EMR type on the normal subcarriers

A.2.3. Recording facilities

X-T Chart Recorders - two channels - Type HP Mosley

X-T Light sensitive fast Recorder - 16 channels

Magnetic Tape Recorder - Ampex 2400

A.2.4. Command

Total commands: 23 tone commands - 32 digital commands

Flight termination: two redundant commands with security feature

Flight control commands: minimun 6 - maximum 10

Coding: resonant reed relay

Private line security

Transmitter: 149.4 MHz - 65 W RF output power

Modulation: Narrow band FM

Antenna: 2 dipole - 6 element yagui - 10 db gain over dipole

A.3. TRAJECTORY DETERMINATION

The slant distance is measured by a phase-shift ranging system. For phase shift measurements it uses frequencies of 225 Hz and 900 Hz, carried back

and forth by the command and telemetry system.

The angular direction is determined by an automatic system that compares the output of the four antenna dipoles.

Typical errors are $\pm$ 2° in angle determination, $\pm$ 2 km in the ranging lecture below 200 km, $\pm$ 4 km when the distance is over 200 km.

A.4. FLIGHT TERMINATION

Normally the termination is actuated from the tracking plane which is equipped with an ADF receiver and a VHF transceiver for linkage with the control station.

Emergency termination is achieved by a command box during launching or from the control station in case of balloon failure or other causes.

An adjustable timer gives redundant termination mode in case of command failure.

A5. DOWN RANGE STATION (DRS)

For flights over 550 km a down range station is available. The MBLS has a trailer fully equipped which can house a compelte ground station and some experimenter's ground equipment. Arrangements are presently beirg made for linking the down ranse station to the commercial telephone network so that a reliable communication link could be set between the DRS and the MBLS.